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FINAL

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR K060

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TABLE OF CONTENTS

Section		Page No.
1.	INTRODUCTION AND SUMMARY	1-1
2.	INDUSTRY AFFECTED AND WASTE CHARACTERIZATION	2-1
	2.1 Industry Affected and Process Description	2-1
	2.2 Waste Characterization	2-3
3.	APPLICABLE AND DEMONSTRATED TREATMENT TECHNOLOGIES	3-1
	3.1 Applicable Treatment Technologies	3-1
	3.2 Demonstrated Treatment Technologies	3-4
4.	PERFORMANCE DATA	4-1
5.	DETERMINATION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)	5-1
	5.1 BDAT for Organics	5-2
	5.2 BDAT for Cyanides	5-3
6.	SELECTION OF REGULATED CONSTITUENTS	6-1
	6.1 Identification of BDAT List Constituents	6-1
	6.2 Constituent Selection	6-2
7.	DEVELOPMENT OF BDAT TREATMENT STANDARDS	7-1
8.	REFERENCES	8-1

LIST OF TABLES

		Page No.
Table 1-1	Treatment Standards for K060 Waste	1-5
Table 2-1	Total Content Analysis of Ammonia Still Prelimer Line Sludge	2-4
Table 2-2	Characterization Data for Samples Taken Before and After Treatment of Coke-Making Facility Wastewaters	2-5
Table 4-1	Analytical Results for K087 Untreated Waste Collected Prior to Treatment by Rotary Kiln Incineration	4-4
Table 4-2	Analytical Results for Kiln Ash Generated by Rotary Kiln Incineration of K087 Waste	4-6
Table 4-3	Analytical Results for Scrubber Water Generated by Rotary Kiln Incineration of K087 Waste	4-8
Table 4-4	Characterization Data for Samples Taken Before and After Treatment of Coke-Making Facility Wastewaters	4-10
Table 6-1	Potential Candidates for Regulation	6-3
Table 7-1	Calculation of Nonwastewater Treatment Standards for Regulated Constituents in K060 Waste	7-4
Table 7-2	Calculation of Wastewater Treatment Standards for Regulated Constituents in K060 Waste	7-5
Table 7-3	Treatment Standards for K060 Waste	7-6

LIST OF FIGURES

		Page No.
Figure 2-1	Ammonia Still Lime Sludge Gereration	2-2

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1. INTRODUCTION AND SUMMARY

Pursuant to section 3004(m) of the Resource Conservation and Recovery Act (RCRA) as enacted by the Hazardous and Solid Waste Amendments on November 8, 1984, the Environmental Protection Agency (EPA) is promulgating best demonstrated available technology (BDAT) treatment standards for K060 waste (ammonia still lime sludge resulting from addition of lime during ammonia stripping). Compliance with the BDAT treatment standards is a prerequisite for the placement of the waste in facilities designated as land disposal units according to 40 CFR Part 268. The effective date of the K060 treatment standards is August 8, 1990.

This background document provides the Agency's technical support and rationale for selecting and developing the proposed treatment standards for the constituents to be regulated in K060 waste. This document explains how EPA determines BDAT, selects constituents for regulation, and calculates treatment standards. Section 2 presents waste-specific information--the number and location of facilities affected by the land disposal restrictions, the waste-generating process, and waste characterization data. These data serve as a basis for determining whether a variance from treatment standards may be warranted for a particular type of K060 that is more difficult to treat than the wastes that were analyzed in developing the K060 treatment standards. Section 3 discusses the technologies used to treat the waste (or similar wastes), and Section 4 presents available performance data, including data on which the treatment standards are based. Section 5 explains EPA's determination of BDAT, while Section 6 discusses the selection of constituents to be regulated. The treatment standards are determined in Section 7.

The BDAT program, the Agency's legal authority, and promulgated methodology are described in detail in two additional documents:

Methodology for Developing BDAT Treatment Standards (USEPA 1989e) and Generic Quality Assurance Project Plan for Land Disposal Restrictions Program ("BDAT") (USEPA 1987). The petition process to be followed in requesting a variance from the BDAT treatment standards is also discussed in the methodology document.

Under 40 CFR 261.32, wastes identified as K060 are listed as follows: ammonia still lime sludges. The Agency believes that only one facility generates this waste; this facility claims that it recycles K060.

In the August 17, 1988, final rule, the Agency promulgated "No Land Disposal Based on No Generation" for K060 nonwastewaters. EPA amended this standard in the May 2, 1989, rule to apply only to certain newly generated wastes. The Agency is revoking this standard since a facility can use ammonia instead of the currently used sodium hydroxide as a reagent in the coking process and thereby generate K060.

Five constituents are being regulated in both nonwastewater and wastewater forms of K060 waste--benzene, benzo(a)pyrene, naphthalene, phenol, and total cyanides. For the purpose of determining the applicability of the treatment standards, wastewaters are defined as wastes containing less than 1 percent (weight basis) total suspended solids* and less than 1 percent (weight basis) total organic carbon (TOC). Waste not meeting this definition must comply with the treatment standards for nonwastewaters.

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* The term "total suspended solids" (TSS) clarifies EPA's previously used terminology of "total solids" and "filterable solids." Specifically, the quantity of total suspended solids is measured by Method 209c, Total Suspended Solids Dried at 103 to 105°C, in Standard Methods for the Examination of Water and Wastewater, 16th Edition (APHA, AWWA, and WPCF 1985).

The Agency does not have performance data for treatment of K060; therefore, the promulgated treatment standards for the regulated volatile and semivolatile organic constituents and cyanides in the nonwastewater form are transferred from treatment performance from incineration of K087 wastes. The Agency believes that the transfer is technically feasible because these two wastes are generated from the same industry and contain the same constituents.

The promulgated treatment standard for these regulated volatile and semivolatile organic constituents and cyanides in the wastewater residual are transferred from treatment performance of biological treatment followed by settling and clarification. The wastewater treatment performance data are available from the EPA Office of Water Development Document for Effluent Guidelines and Standards for the Iron and Steel Industry Manufacturing Point Source Category Coke Making Manufacture (USEPA 1982). The Agency is regulating only total cyanides as opposed to both total and amenable cyanides because the characterization data appearing in Section 2 show amenable cyanides present in the untreated waste at <1.0 ppm, while total cyanides are present at higher levels in the untreated waste.

Table 1-1 lists the specific nonwastewater and wastewater treatment standards for K060 waste. The treatment standards for organics and total cyanides reflect the total constituent concentration; the units are mg/kg (parts per million on a weight-by-weight basis) for the nonwastewaters and mg/l (parts per million on a weight-by-volume basis) for the wastewaters. Wastewater numbers are based on a 24-hour composite grab sample.

Table 1-1 Treatment Standards for K060 Waste

Constituent	Nonwastewaters: Total concentration (mg/kg) (grab samples)	Wastewaters: Total concentration (mg/l) (24-hour composite sample except for cyanides)
Volatile organics		
Benzene	0.071	0.17
Semivolatile organics		
Benzo(a)pyrene	3.6	0.035
Naphthalene	3.4	0.028
Phenol	3.4	0.042
Inorganics		
Cyanides (total)	1.2	6.6

NA = Not applicable.

2. INDUSTRY AFFECTED AND WASTE CHARACTERIZATION

According to 40 CFR 261.32, the waste K060 is listed as follows:

K060: Ammonia still lime sludge from addition of lime during ammonia stripping.

This section describes the K060 waste, its generation, and the industry affected by the land disposal restriction of the waste.

2.1 Industry Affected and Process Description

K060 waste is a coke-making byproduct waste from the iron and steel industry (Standard Industrial Classification (SIC) code 3312). The Agency knows of only one facility that currently generates K060 waste as listed. This facility claims that its K060 is being recycled.

The following description of the process was presented in the RCRA Listing Background Document for K060 (USEPA 1980).

Ammonia still lime sludge is generated from coke-manufacturing operations during the recovery of ammonia by the addition of lime to the ammonia still contents. Figure 2-1 illustrates the process from which the waste K060 is generated. In this process, excess ammonia liquor is passed through stills to strip the ammonia (NH_3) from solution for subsequent recovery as ammonium sulfate, phosphate, or hydroxide. About half of the ammonia originally present strips readily, but the remaining fraction can be recovered only by elevating the pH of the waste liquor to 10-12 through the addition of lime and then passing additional steam through the solution. This stripping transfers the rest of the ammonia to the gas stream. Other ammonia liquor components remain behind. As a result, the lime sludges contain treatable levels of hazardous constituents.

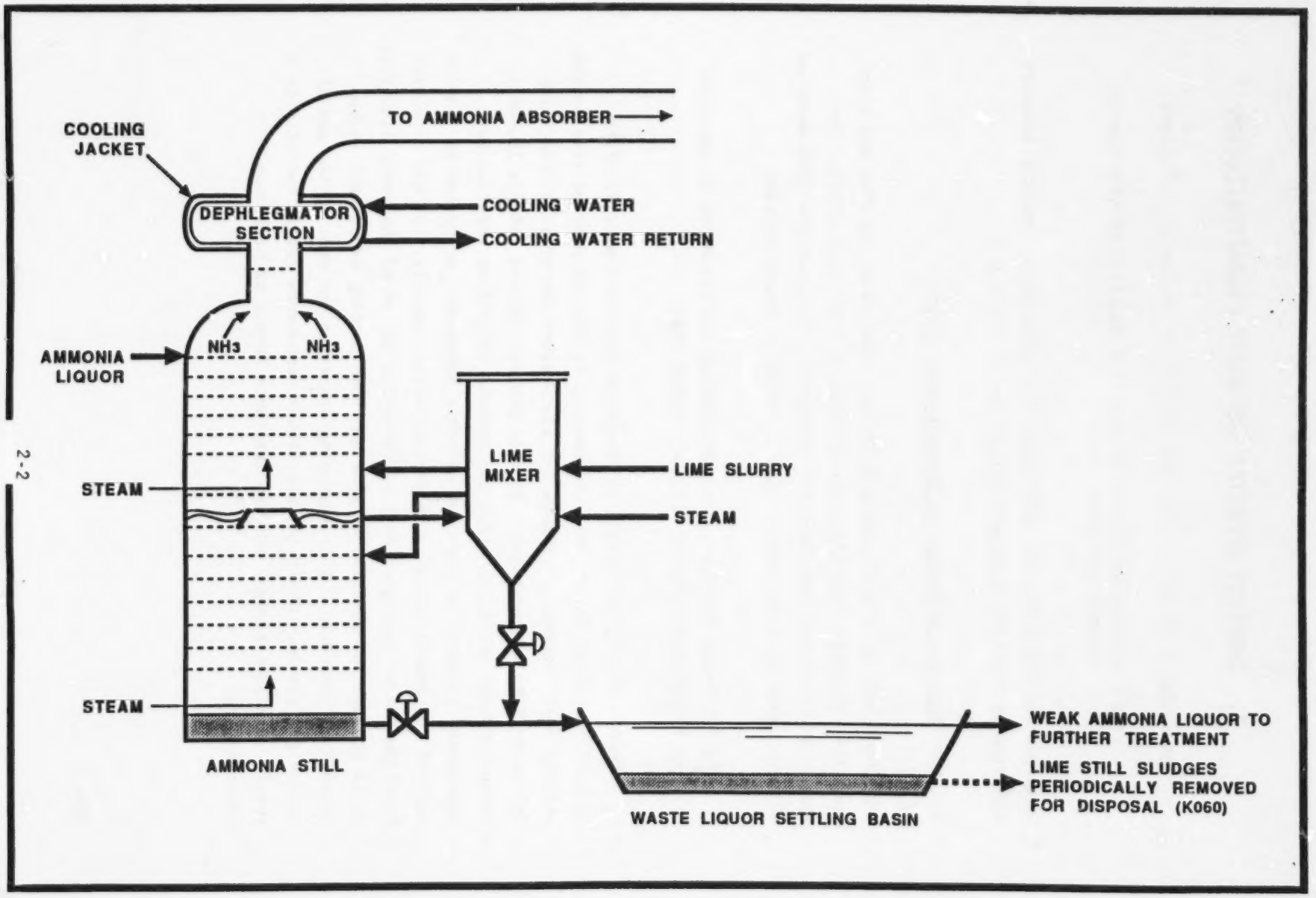

FIGURE 2-1 AMMONIA STILL LIME SLUDGE GENERATION

2.2 Waste Characterization

Some characterization data are available from the EPA Office of Solid Waste relisting effort, including data on BDAT list constituent concentrations in ammonia still "prelimer" lime sludge obtained at two byproduct coke plants.* These data are not from K060. The prelimer consists of a continuous treatment tank in which lime is added to the raw ammonia-rich liquor prior to stripping. By not adding the lime directly into the still, the generator of the "prelimer" waste avoids a K060 listing for this waste material. The analyses of the sludge formed in the prelimer provide an indication of the BDAT list constituents expected to be present in K060 wastewater (see Table 2-1). These constituents include benzene, phenols, naphthalene, and cyanides. The pollutant levels shown represent concentrations in the solid portion of the sludge and provide no indication of what levels would exist in the wastewater leaving the ammonia stripper.

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* Data to be presented in a forthcoming EPA/OSW background document: Analytical Data Report for Bethlehem Steel Corp., Bethlehem, Pennsylvania. EPA Contract 68-01-7287, Work Assignment 14, MRI Project 9101-13.

Table 2-1 Total Content Analysis of Ammonia Still Prelimer Lime Sludge

Constituent	Coke Plant 3 (mg/kg)	Coke Plant 7 (mg/kg)
Phenol	140	533
2-Methyl phenol	20.9	106
4-Methyl phenol	59.6	286
2,4-Dimethylphenol	5.44	27.2
Naphthalene	6.14	199
Acenaphthylene	3.48	224
Acenaphthene	0.166	15.1
Fluorene	1.78	194
Phenanthrene	5.13	370
Anthracene	2.27	160
Fluoranthene	4.32	269
Pyrene	2.44	202
Benz(a)anthracene	1.26	155
Chrysene	1.24	115
Benzo(b)fluoranthene	4.86	289
Benzo(k)fluoranthene[a]	--	--
Benzo(a)pyrene	1.98	93.1
Dibenz(a,h)anthracene	<0.12	17.0
Indeno(1,2,3-c,d)pyrene	<0.12	38.4
Benzo(g,h.i)perylene	2.80	34.1
Arsenic	2.7 (0.055 mg/l)[b]	83.5 (0.059 mg/l)[b]
Barium	3.1 (1.52 mg/l)[b]	10.7 (1.37 mg/l)[b]
Cadmium	<0.4 (<0.004 mg/l)[b]	<0.4 (0.007 mg/l)[b]
Chromium	3.8 (0.008 mg/l)[b]	7.40 (0.015 mg/l)[b]
Lead	<5.1 (0.051 mg/l)[b]	6.85 (<0.051 mg/l)[b]
Cyanide, total	0.44 (15.9 mg/l)[b]	769 (11.6 mg/l)[b]
Cyanide, amenable	<1.0 (10.5 mg/l)[b]	<1.0 (10.8 mg/l)[b]

[a] Included with benzo(b)fluoranthene.

[b] Concentrations in parentheses are TCLP extract concentrations.

Source: Unpublished data obtained under the EPA/OSW hazardous waste listing program effort for the byproduct coke-making industry.

Table 2-2 Characterization Data for Samples Taken Before and After Treatment of Coke-Making Facility Wastewaters

Constituents	Concentration (mg/l) Plant 003[a] Before	After
Benzene	27.2	<0.060
2,4,6-Trichlorophenol	ND	ND
Chloroform	1.37	<0.281
2,4-Dimethylphenol	5.33	ND
2,4-Dinitrotoluene	ND	ND
2,6-Dinitrotoluene	ND	ND
Ethylbenzene	0.640	0.039
Fluoranthene	3.13	0.008
Naphthalene	28.9	ND
4,6-Dinitro-o-cresol	ND	ND
Pentachlorophenol	ND	ND
Phenol	327	<0.015
Phthalates, Total	2.30	0.192
Benzo(a)anthracene	ND	<0.002
Benzo(a)pyrene	ND	0.013
Chrysene	ND	<0.006
Acenapthylene	6.37	<0.007
Fluorene	2.47	<0.010
Pyrene	2.63	0.026
Toluene	8.92	0.040
Xylene	<0.01	ND
Antimony	NA	NA
Arsenic	NA	NA
Cyanides	22.3	2.34
Selenium	NA	NA
Silver	<0.00	<0.002
Zinc	0.130	0.060
pH (Units)	9.6-9.8	7.4-7.5

ND = None detected.
NA = Not analyzed.

[a]The "before" column characterizes the feed concentration to the ammonia still; the "after" column shows wastewater concentrations following biological treatment, settling, and clarification.

Source: USEPA 1982, Table VII-3, p. 88.

3. APPLICABLE AND DEMONSTRATED TREATMENT TECHNOLOGIES

This section identifies the treatment technologies that are applicable to K060 waste and determines which, if any, of the applicable technologies can be considered demonstrated for the purposes of establishing BDAT.

To be applicable, a technology must be theoretically usable to treat the waste in question, or to treat a waste that is similar in terms of the parameters that affect treatment selection. (For detailed descriptions of the technologies applicable for these wastes, or for wastes judged to be similar, see EPA's Treatment Technology Background Document (USEPA 1989b).) To be demonstrated, the technology must be employed in full-scale operation for the treatment of the waste in question or a similar waste. Technologies available only at research facilities or in pilot- and bench-scale operations are not considered in identifying demonstrated technologies.

3.1 Applicable Treatment Technologies

As explained in Section 2.2, K060 waste may contain organic constituents and cyanides. Applicable technologies for treating organic constituents in a waste or in any resulting treatment residuals include technologies that destroy or reduce the amount of the constituents present in the waste. Applicable technologies for cyanides include those that destroy or reduce the amount of cyanides present in a waste. The applicable technologies that are described below were identified based on current literature sources, field testing, and current waste treatment practices.

The Agency has identified fuel substitution and incineration as applicable technologies for treating the organic constituents and

cyanides in untreated as-generated K060 waste. Also, because the one facility that is believed to generate K060 recycles this waste, recycling is considered an applicable technology. As treatment processes, fuel substitution and incineration have the same purpose: to thermally destroy the organic constituents and cyanide in the waste by converting them to carbon dioxide and water. Fuel substitution, in addition, uses the waste as a substitute for conventional fuels burned in high-temperature industrial processes.

Both fuel substitution and incineration generally result in nonwastewater and wastewater treatment residuals such as ash, clarifier solids from the flue gas scrubber system, and scrubber water, which may require further treatment. The residuals from treatment of K060 waste in a well-designed, well-operated fuel substitution combustion device or incinerator are not expected to contain detectable levels of organic constituents or cyanide and thus should not require further treatment for organics.

The wastewater residual generated by incineration of K060 waste is not expected to contain treatable levels of organics. If, however, a K060 wastewater is generated via landfill leachate or through mixture with other wastes, the organics in the wastewater probably will require treatment. The Agency has identified wet air oxidation, biological treatment, and carbon adsorption as applicable technologies in treating the wastewater form of K060.

Wet air oxidation is a treatment technology applicable to wastewaters containing organics and cyanides and is typically used to oxidize sludge, regenerate spent activated carbon, and treat process wastewaters. This technology can be used to treat wastewaters that have higher organic concentrations than are normally handled by biological treatment, carbon adsorption, and chemical oxidation, but may be too dilute to be effectively treated by thermal processes such as incineration. Wet air

oxidation is most applicable for waste streams containing dissolved or suspended organics in the 500 to 15,000 mg/l range. Below 500 mg/l, the rates of wet air oxidation of most organic constituents are too slow for efficient application of this technology. For these more dilute waste streams, biological treatment, carbon adsorption, or chemical oxidation may be more applicable. For more concentrated waste streams (above 15,000 mg/l), thermal processes such as incineration may be more applicable. Wet air oxidation can also be applied to wastes that have significant concentrations of metals (roughly 2 percent), whereas biological treatment, carbon adsorption, and chemical oxidation may have difficulty in treating such wastes.

Biological treatment is a technology that uses living microorganisms to decompose organic constituents and can also be used to treat cyanides at relatively low concentrations. Biological treatment can occur either in the presence of oxygen, where it is known as aerobic treatment, or in the absence of oxygen, where it is referred to as anaerobic treatment. The organic constituents are broken down into water, carbon dioxide, and other organic constituents by the microorganisms.

Carbon adsorption is a separation technology used to remove and/or recover dissolved organics and certain inorganics from aqueous streams by adsorbing the dissolved constituents onto the surface of the activated carbon particles. Powdered or granular activated carbon particles are used as the adsorbing medium in this technology.

The above technologies applicable to treating wastewaters containing organics are discussed in detail in the Treatment Technology Background Document (USEPA 1989b).

Because K060 waste contains cyanides, wastewater residuals may contain treatable levels of these compounds. The scrubber water

generated by incineration of K060 waste is not expected to contain treatable levels of cyanides. If, however, a K060 wastewater is generated via landfill leachate or mixture with other wastes, the cyanides will require further treatment. The applicable technology for treatment of cyanides in K060 is biological treatment which has been previously described. The nonwastewater residuals of K060 should not contain treatable levels of cyanides; these constituents in the nonwastewater form should be adequately destroyed during incineration.

3.2 Demonstrated Treatment Technologies

The only known generator of K060 waste is believed to recycle this waste; therefore, the Agency has no data indicating that incineration or fuel substitution is being used on K060 waste. The Agency does have data, however, on incineration of K087, a waste believed to be similar to K060. These wastes are believed similar because both K087 and K060 are generated through the manufacture of coke in the iron and steel industry and because both wastes contain similar constituents (i.e., benzene, phenols, naphthalene, and cyanides) that are present in treatable concentrations. EPA believes, therefore, that incineration would be a demonstrated technology for K060 waste in destroying nonwastewater organic and cyanide constituents.

Incineration, as stated previously, is a demonstrated treatment technology for organic and cyanide nonwastewater removal in K060 waste. Also, as previously discussed, recycling is a demonstrated technology for K060 because the only facility currently generating K060 recycles this waste.

The Agency has no data indicating that wet air oxidation, carbon adsorption, or biological treatment are being used on K060 wastewaters. Data are available, however, for biological treatment of a waste similar

to K060 in that it is generated by the iron and steel industry in coke manufacturing and the constituents treated by biological treatment (naphthalene, phenols, benzene, and cyanides) are also present in treatable levels in K060. The Agency believes that biological treatment is a demonstrated technology for treatment of organics and cyanides in K060 wastewaters.

4. PERFORMANCE DATA

This section presents the data available to EPA on the performance of demonstrated technologies in treating the listed wastes. These data are used elsewhere in this document for determining which technologies represent BDAT (Section 5), for selecting constituents to be regulated (Section 6), and for developing treatment standards (Section 7). Eligible data, in addition to full-scale demonstration data, may include data developed at research facilities or obtained through other applications at less than full-scale operation, as long as the technology is demonstrated in full-scale operation for a similar waste or wastes as defined in Section 3.

Performance data, to the extent that they are available to EPA, include the untreated and treated waste concentrations for a given constituent, values of operating parameters that were measured at the time the waste was being treated, values of relevant design parameters for the treatment technology, and data on waste characteristics that affect performance of the treatment technology.

Since data are not available on the treatment of K060 wastes, the Agency has elected to transfer treatment performance for a similar waste, using a demonstrated technology. To transfer treatment performance data from another waste category, EPA must find that the wastes covered by this background document are no more difficult to treat (based on the waste characteristics that affect performance of the demonstrated treatment technology) than the treated waste from which performance data are being transferred.

No performance data are available to the Agency to characterize treatment of organics and cyanides in K060 nonwastewaters. However, the Agency has data for incineration of a similar organic waste, K087, which,

as defined by 40 CFR 261.32, is the decanter tank car sludge from coking operations. This similarity is based on the production processes, the waste compositions, and the waste characteristics affecting performance of the demonstrated treatment technology. The waste characteristics affecting performance of incineration are bond dissociation energies and boiling points. These are described in the Treatment Technology Background Document (USEPA 1989b). Evaluation of the waste composition for K060 reveals that the primary constituents of concern in K060 are present in higher concentrations in K087. For instance, K060 contains phenol at 533 ppm at its highest value while K087 contains phenol at 1,800 ppm. Therefore, the Agency is transferring performance data for organics and cyanides in the nonwastewater form of K060 from the treatment of K087 wastes since the Agency believes that K060 is no more difficult to treat than the tested K087 waste.

No performance data are available to characterize treatment of organics and cyanides in K060 wastewaters. Data are available for biological treatment of organics and cyanides in wastewaters from the Office of Water Development Document for Effluent Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category Coke Making Manufacture (USEPA 1982). The Agency believes that wastewaters generated from the Effluent Guidelines process have similar characteristics to K060 wastewaters because the wastewaters are generated from a similar industry (coke making) and a process that is nearly identical to the K060 process (the Effluent Guidelines process uses a prelimer; K060 does not).

The performance data used for transfer include the untreated and treated waste concentrations for a given constituent, the values of operating parameters that were measured at the time the waste was being treated, the values of relevant design parameters for the treatment technology, and data on waste characteristics that affect the performance of the treatment technology.

Because the Agency is transferring performance data from K087 to K060 for organic and cyanide nonwastewaters, tables 4-1 through 4-3 present the data of total waste concentration analyses for treated and untreated K087 waste. In all cases, the BDAT list organics and cyanides detected in the K087 untreated waste are reduced to nondetectable levels in the treated residuals. Table 4-4 presents the data of total waste concentration analyses for treated and untreated organics and cyanides in a coke manufacturing wastewater.

Table 4-1 Analytical Results for K087 Untreated Waste Collected Prior to Treatment by Rotary Kiln Incineration

Constituent/parameter (units)	Concentration				
	Sample set #				
	1	2	3	4	5
BDAT Volatile Organics (mg/kg)					
Benzene	17	19	5.6	212	170
Methyl ethyl ketone	<2.0	<2.1	<2.0	<10	<10
Toluene	17	17	5.0	152	130
Xylenes	21	23	3.0	123	121
BDAT Semivolatile Organics (mg/kg)					
Acenaphthalene	11000	12000	10000	13000	10000
Anthracene	7500	8100	7100	8100	6700
Benz(a)anthracene	5700	5900	5600	7500	5400
Benzo(b)fluoranthene	3200	<1010	3100	<982	5300
Benzo(k)fluoranthene	3100	7500	3100	9300	<1026
Benzo(a)pyrene	4100	4300	4100	5400	3800
Chrysene	5100	5300	5100	6500	4700
para-Cresol	1600	1600	1300	1900	1200
Fluoranthene	11000	12000	11000	<982	11000
Fluorene	7600	7900	7000	9300	7000
Indeno(1,2,3-c,d)pyrene	2100	2500	2300	3100	2100
Naphthalene	64000	66000	64000	81000	63000
Phenanthrene	34000	34000	15000	41000	15000
Phenol	1600	1500	1200	1800	1200
Pyrene	9100	5900	8000	9700	8100
BDAT Metals (mg/kg)[a]					
Antimony	<2.0	<2.0	<2.0	<2.0	<2.0
Arsenic	6.1	6.1	5.5	1.9	5.2
Barium	<20	<20	<20	<20	<20
Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5
Cadmium	1.7	2.1	2.1	1.7	1.9
Chromium	<2.0	<2.0	<2.0	<2.0	<2.0
Copper	3.2	4.5	3.2	<2.5	2.6
Lead	85	80	72	64	69
Mercury	2.9	3.6	3.8	4.2	3.3
Nickel	<4.0	4.6	<4.0	<4.0	<4.0
Selenium	1.2	1.6	1.3	1.4	1.2
Silver	<5.0	<5.0	<5.0	<5.0	<5.0
Thallium	2.7	2.3	2.2	2.1	2.2
Vanadium	<5.0	<5.0	<5.0	<5.0	<5.0
Zinc	63	63	58	50	66

Table 4-1 (continued)

Constituent/parameter (units)	Concentration, Sample set #				
	1	2	3	4	5
BDAT Inorganics Other Than Metals (mg/kg)					
Cyanide	22.8	18.2	21.1	22.0	17.9
Fluoride	0.38	-	-	-	0.18
Sulfide	323	320	275	293	302
Non-BDAT Volatile Organics (mg/kg)					
Styrene	12	12	3.4	26	71
Non-BDAT Semivolatile Organics (mg/kg)					
Dibenzofuran	5300	5600	5200	6800	5000
2-Methylnaphthalene	7000	6900	6300	9400	6200
Other Parameters					
Ash content (%)	2.9	3.4	9.7	3.7	2.7
Heating value (Btu/lb)	15095	14898	14823	15336	14959
Percent water (%)	5.70	10.31	11.26	7.72	6.60
Total halogens as chlorine (%)	0.033	0.023	0.026	0.045	0.057
Total organic carbon (%)	83.67	76.38	84.27	79.10	85.57
Total organic halides (mg/kg)	27.0	28.0	29.3	87.7	25.8
Total solids (%)[b]	87.7	90.5	91.1	89.7	86.5
Viscosity[c]	-	-	-	-	-
Elemental constituents (%)					
Carbon	83.80	81.90	84.01	66.36	77.54
Hydrogen	5.62	5.14	5.27	6.46	5.97
Nitrogen	1.13	1.06	1.03	0.82	0.96
Oxygen	9.13	11.94	10.25	26.59	15.71

- = Not analyzed.
ND = Not detected; estimated detection limit has not been determined.

[a]Results have been reported on a wet weight basis.
[b]Total solids results are biased low because of test complications arising from waste matrix.
[c]Because of the high concentration of solids in the waste, viscosity values could not be determined.

Note: This table shows concentrations or maximum potential concentrations in the untreated waste for all constituents detected in the untreated waste or detected in the residuals generated by treatment of the waste.

Source: USEPA 1988a.

Table 4-2 Analytical Results for Kiln Ash Generated by Rotary Kiln Incineration of K087 Waste

Constituent/parameter (units)	Concentration				
	Sample set #				
	1	2	3	4	5
BDAT Volatile Organics (µg/kg)					
Benzene	<25	<25	<25	<25	<25
Methyl ethyl ketone	<25	<25	<25	<25	<25
Toluene	150	85	<25	<25	190
Xylenes	<25	<25	<25	<25	<25
BDAT Semivolatile Organics (µg/kg)					
Acenaphthalene	<1000	<1000	<1000	<1000	<1000
Anthracene	<1000	<1000	<1000	<1000	<1000
Benz(a)anthracene	<1000	<1000	<1000	<1000	<1000
Benzo(b)fluoranthene	<1000	<1000	<1000	<1000	<1000
Benzo(k)fluoranthene	<1000	<1000	<1000	<1000	<1000
Benzo(a)pyrene	<1000	<1000	<1000	<1000	<1000
Chrysene	<1000	<1000	<1000	<1000	<1000
para-Cresol	<1000	<1000	<1000	<1000	<1000
Fluoranthene	<1000	<1000	<1000	<1000	<1000
Fluorene	<1000	<1000	<1000	<1000	<1000
Indeno(1,2,3-c,d)pyrene	<1000	<1000	<1000	<1000	<1000
Naphthalene	<1000	<1000	<1000	<1000	<1000
Phenanthrene	<1000	<1000	<1000	<1000	<1000
Phenol	<1000	<1000	<1000	<1000	<1000
Pyrene	<1000	<1000	<1000	<1000	<1000
BDAT Metals (mg/kg)					
Antimony	<3.2	<2.0	<2.0	<2.0	<3.2
Arsenic	9.9	11	6.7	12	5.3
Barium	317	56	53	41	63
Beryllium	0.60	<0.5	<0.5	<0.5	0.36
Cadmium	<0.40	<1.0	<1.0	<1.0	<0.40
Chromium	34	5.2	2.2	2.1	7.6
Copper	746	44	43	50	94
Lead	44	8.2	8.3	5.9	7.2
Mercury	<0.10	2.8	2.9	3.3	<0.1
Nickel	10	<4.0	<4.0	<4.0	4.5
Selenium	1.4	1.6	<0.50	5.9	<0.5
Silver	<0.60	<5.0	<5.0	<5.0	<6.0
Thallium	<1.0	<1.0	<1.0	<1.0	<1.0
Vanadium	17	9.7	6.6	8.1	10
Zinc	50	13	13	12	21

Table 4-2 (continued)

Constituent/parameter (units)	Concentration				
	Sample set #				
	1	2	3	4	5
BDAT TCLP: Metals (µg/l)					
Antimony	425	<20	<20	<20	<32
Arsenic	96	33	25	19	43
Barium	609	344	547	641	546
Beryllium	3.3	<5.0	<5.0	<5.0	2.5
Cadmium	<4.0	<10	<10	<10	<4.0
Chromium	62	<20	<20	<20	8.7
Copper	<6.0	52	1110	346	497
Lead	29	40	53	20	106
Mercury	<0.2	<0.30	<0.30	<0.30	<0.2
Nickel	93	<40	<40	<40	16
Selenium	<50	7.3	<5.0	<5.0	<5.0
Silver	<6.0	<50	<50	<50	<6.0
Thallium	<10	<10	<10	<10	<500
Vanadium	<30	<50	<50	<50	8.3
Zinc	169	202	218	288	256
BDAT Inorganics Other Than Metals (mg/kg)					
Cyanide	0.74	<0.50	<0.50	<0.50	<0.50
Fluoride	<1.0	-	-	-	<0.25
Sulfide	35.5	36.3	144	116	11.0
Non-BDAT Volatile Organics (µg/kg)					
Styrene	<25	<25	<25	<25	<25
Non-BDAT Semivolatile Organics (µg/kg)					
Dibenzofuran	<1000	<1000	<1000	<1000	<1000
2-Methylnaphthalene	<1000	<1000	<1000	<1000	<1000
Other Parameters (mg/kg)					
Total organic carbon	350000	553000	402000	316000	244000
Total chlorides	9.7	6.8	14.1	14.6	16.0
Total organic halides	375	18.3	32.1	19.8	133

- = Not analyzed.

Note: This table shows the concentrations or maximum potential concentrations in the kiln ash for all constituents that were detected in the untreated waste or detected in residuals generated from treatment of the waste.

Source: USEPA 1988a.

Table 4-3 Analytical Results for Scrubber Water Generated by Rotary Kiln Incineration of K087 Waste

Constituent/parameter (units)	Concentration					
	Sample[a]					
	1	2	3	4	5	6
BDAT Volatile Organics (µg/l)						
Benzene	<5	<5	<5	<5	<5	<5
Methyl ethyl ketone	14	<10	<10	<10	<10	<10
Toluene	<5	8	<5	<5	<5	<5
Xylenes	<5	<5	<5	<5	<5	<5
BDAT Semivolatile Organics (µg/l)						
Acenaphthalene	<10	<10	<10	<10	<10	<10
Anthracene	<10	<10	<10	<10	<10	<10
Benz(a)anthracene	<10	<10	<10	<10	<10	<10
Benzo(b)fluoranthene	<10	<10	<10	<10	<10	<10
Benzo(k)fluoranthene	<10	<10	<10	<10	<10	<10
Benzo(a)pyrene	<10	<10	<10	<10	<10	<10
Chrysene	<10	<10	<10	<10	<10	<10
para-Cresol	<10	<10	<10	<10	<10	<10
Fluoranthene	<10	<10	<10	<10	<10	<10
Fluorene	<10	<10	<10	<10	<10	<10
Indeno(1,2,3-cd)pyrene	<10	<10	<10	<10	<10	<10
Naphthalene	<10	<10	<10	<10	<10	<10
Phenanthrene	<10	<10	<10	<10	<10	<10
Phenol	<10	<10	<10	<10	<10	<10
Pyrene	<10	<10	<10	<10	<10	<10
BDAT Metals (µg/l)						
Antimony	<32	<33	<20	39	<20	<32
Arsenic	211	191	148	257	300	342
Barium	65	350	302	340	290	102
Beryllium	<1.0	1.3	<5.0	<5.0	<5.0	<1.0
Cadmium	26	15	21	41	42	51
Chromium	306	304	155	236	255	259
Copper	1050	1100	948	1240	1160	1240
Lead	5610	7000	3240	4780	5610	4840
Mercury	0.23	<0.20	0.48	0.33	0.30	0.40
Nickel	<11	<11	<40	<40	<40	<11
Selenium	81	61	5.7	83	87	87
Silver	<6.0	<7.0	<50	<50	<50	<6.0
Thallium	126	109	77	108	96	136
Vanadium	15	12	<50	<50	<50	18
Zinc	2250	2040	1740	2910	2670	2960

Table 4-3 (Continued)

Constituent/parameter (units)	Concentration					
	Sample[a]					
	1	2	3	4	4	6
BOAT Inorganics Other Than Metals (mg/l)						
Cyanide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoride	3.38	2.99	2.38	-	-	3.54
Sulfide	<1.0	<1.0	11.9	<1.0	<1.0	<1.0
Non-BOAT Volatile Organics (µg/l)						
Styrene	<5	<5	<5	<5	<5	<5
Non-BOAT Semivolatile Organics (µg/l)						
Dibenzofuran	<10	<10	<10	<10	<10	<10
2-Methylnaphthalene	<10	<10	<10	<10	<10	<10
Other Parameters						
Total organic carbon (mg/l)	37.9	26.1	88.9	148	111	94.1
Total solids (mg/l)	2240	2080	1910	2350	2480	2720
Total chlorides (mg/l)	51.3	57.9	48.5	51.0	58.3	56.0
Total organic halides (µg/l)	33.7	33.2	48.7	23.3	27.6	27.4

- = Not analyzed.

[a]Scrubber water samples are not assigned a sample set number.

Note: This table shows concentrations or maximum potential concentrations in the scrubber water for all constituents detected in the untreated waste or detected in residuals generated from treatment of the waste.

Source: USEPA 1988a.

Table 4-4 Characterization Data for Samples Taken Before and After Treatment of Coke-Making Facility Wastewaters

Constituents	Concentration (mg/l) Plant 003[a] Before	After
Benzene	27.2	<0.060
2,4,6-Trichlorophenol	ND	ND
Chloroform	1.37	<0.281
2,4-Dimethylphenol	5.33	ND
2,4-Dinitrotoluene	ND	ND
2,6-Dinitrotoluene	ND	ND
Ethylbenzene	0.640	0.039
Fluoranthene	3.13	0.008
Naphthalene	28.9	ND
4,6-Dinitro-o-cresol	ND	ND
Pentachlorophenol	ND	ND
Phenol	327	<0.015
Phthalates, Total	2.30	0.192
Benzo(a)anthracene	ND	<0.002
Benzo(a)pyrene	ND	0.013
Chrysene	ND	<0.006
Acenapthylene	6.37	<0.007
Fluorene	2.47	<0.010
Pyrene	2.63	0.026
Toluene	8.92	0.040
Xylene	<0.01	ND
Antimony	NA	NA
Arsenic	NA	NA
Cyanides	22.3	2.34
Selenium	NA	NA
Silver	<0.00	<0.002
Zinc	0.130	0.060
pH (Units)	9.6-9.8	7.4-7.5

ND = None detected.
NA = Not analyzed.

[a]The "before" column characterizes the feed concentration to the ammonia still; the "after" column shows wastewater concentrations following biological treatment, settling, and clarification.

Source: USEPA 1982, Table VII-3, p. 88.

5. IDENTIFICATION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

This section presents the Agency's rationale for determining best demonstrated available technology (BDAT) for K060 nonwastewaters and wastewaters.

To determine BDAT, the Agency examines all available performance data on technologies that are identified as demonstrated on the waste of concern or similar wastes to determine (using statistical techniques) whether one or more of the technologies performs significantly better than the others. All performance data used for determination of best technology must first be adjusted for accuracy, as discussed in EPA's publication, Methodology for Developing BDAT Treatment Standards (USEPA 1989c). (An accuracy adjustment accounts for the ability of an analytical technique to recover a particular constituent from the waste in a particular test. The recovery of a constituent is usually determined by spiking a sample with a known amount of the target constituent and then comparing the spiked sample amounts with results from unspiked samples.) Accuracy adjustment is further discussed in Section 7. BDAT must be specifically defined for all streams associated with the management of the listed waste or wastes; this pertains to the original waste as well as any residual waste streams created by the treatment process. Additionally, the ANOVA test is available to compare data from two or more demonstrated technologies and determine which offers the best treatment. The ANOVA test is described fully in the methodology background document.

The technology that performs best based on ANOVA tests on a particular waste or waste treatability group is then evaluated to determine whether it is "available." To be available, the technology must (1) be commercially available to any generator and (2) provide "substantial" treatment of the waste, as determined through evaluation of accuracy-adjusted data. In determining whether treatment is substantial, EPA may consider data on the performance of a waste similar to the waste

in question provided that the similar waste is at least as difficult to treat. If the best technology is found to be not available, then the next best technology is evaluated, and so on.

5.1 BDAT for Organics

The determination of substantial treatment of organics involves comparing constituent concentrations in the original waste to the respective concentrations in all residual streams from treatment. There are no available organics performance data on K060 waste as generated; however, because of K060's similarity to K087, the Agency believes the "best" technology chosen for K087, incineration, will apply to K060 as well. Incineration is considered BDAT because K087 constituents (which are also contained in K060) are reduced to nondetectable levels in the treated residuals. Incineration of K060 waste as generated (a nonwastewater) would produce scrubber water (wastewater) and incinerator ash (nonwastewater), both of which should also be devoid of organic constituents (i.e., present in amounts less than the detection limit) if the incinerator is well-designed and well-operated. Also, since the K087 constituents were present at higher concentrations than in K060, and were treated to nondetectable levels in K087, incineration is chosen as BDAT.

EPA has determined that incineration is commercially available. Also, EPA believes that incineration provides substantial treatment for organics because the performance data for K087 show that untreated concentrations of constituents that are also present in K060 can be reduced to nondetectable levels in both the residual nonwastewater ash and the residual wastewater stream (the scrubber water). Thus, incineration is "best."

As "best," "demonstrated," and "available," incineration is therefore BDAT for organics in K060 nonwastewaters.

The wastewaters generated by the incineration of K060 are not expected to have detectable levels of organics. If, however, a K060 wastewater is generated by some other method, this wastewater will be expected to contain treatable levels of organics. EPA has determined that biological treatment is an available and demonstrated technology for K060 as shown in Table 4-4. Biological treatment of K060 wastewaters has reduced most of the organic constituents to below detection limit and is therefore considered the "best" treatment technology for organics in K060 wastewaters. Biological treatment is, thus, BDAT for organics in K060 wastewaters.

5.2 BDAT for Cyanides

As discussed in Section 3, cyanides are not expected to be found in the incinerator ash or scrubber waters in concentrations requiring further treatment. Incineration is, therefore, the "best" performing technology for cyanides in K060 nonwastewaters and wastewaters.

For cyanides in K060 wastewaters, the Agency believes that biological treatment is "best" for treating the total cyanides. This is based on the reduction of the total cyanide concentration in the waste tested by the Office of Water as noted in Table 4-4 (since the Office of Water data is being used for the standard). The Agency is, therefore, choosing biological treatment as the best technology to treat cyanides in K060 wastewaters.

6. SELECTION OF REGULATED CONSTITUENTS

This section presents the methodology and rationale for the selection of regulated constituents for the treatment of K060.

Generally, constituents selected for regulation must satisfy the following criteria:

1. They must be on the BDAT list of regulated constituents. (Presence on the BDAT list implies the existence of approved techniques for analyzing the constituent in treated waste matrices.)

2. They must be present in, or be suspected of being present in, the untreated waste. For example, in some cases, analytical difficulties (such as masking) may prevent a constituent from being identified in the untreated waste, but its identification in a treatment residual may lead the Agency to conclude that it is present in the untreated waste.

3. Where performance data are transferred from other constituents, the selected constituents must be easier to treat (based on characterization data) than the waste constituent(s) from which performance data are transferred. Factors for assessing ease of treatment vary according to the technology of concern. For instance, for incineration the factors may include bond dissociation energy, thermal conductivity, and boiling point.

From the group of constituents that are eligible to be regulated (i.e., all constituents on the BDAT list), EPA may select a subset of constituents as representative of the broader group. For example, out of a group of constituents that react similarly to treatment, the Agency might name only those that are the most difficult to treat as regulated constituents for the purpose of setting a standard.

6.1 Identification of BDAT List Constituents

As discussed in Sections 2 and 4, the Agency has no performance data from treatment of organics and cyanides in nonwastewater residuals of K060

waste by incineration. However, untreated waste composition data were obtained from the RCRA Listing Background Document. Performance data for organics and cyanides in nonwastewaters are available from incineration of K087, which the Agency believes is similar to K060 (see Sections 3 and 4): these data, therefore, represent the Agency's source of transfer for K060. Additionally, the Agency has data on wastewaters generated in coke manufacturing (these wastewaters are from "prelimer" lime sludge in coke manufacturing), which the Agency believes represent a waste similar to K060 because K060 is generated as a result of coke manufacturing and contains similar constituents such as phenols, naphthalene, benzene, and cyanides. These data, along with information on the K060 waste-generating process and the RCRA Listing Document data, have been used to determine which BDAT list constituents are, or may be, present in the waste and thus which ones are potential candidates for regulation. Table 6-1 indicates, for the untreated waste, 12 BDAT constituents that the Agency believes are likely to be present based on the listing information. These constituents were also considered as candidates for regulation.

6.2 Constituent Selection

The Agency is proposing to regulate five of the candidate BDAT constituents believed to be present in K060. The proposed organic constituents for regulation are those that are believed to be present in the highest concentrations and are expected to be the most difficult to treat based on the RCRA Listing Document. They are benzene, benzo(a)pyrene, naphthalene, and phenol. Cyanides are considered to be present in treatable concentrations in K060, and they are also listed for K060 in the RCRA Listing Document; therefore, they too are proposed for regulation.

Table 6-1 Potential Candidates for Regulation in K060 Waste

Constituent
Volatile organics
Benzene[a]
Chloroform
Toluene
Semovolatile organics
Acenaphthalene
Benzo(a)pyrene[a]
Fluoranthene
Fluorene
Naphthalene[a]
Phenol[a]
Pyrene
Inorganics
Cyanides[a]

[a] These constituents are selected for regulation.

7. DEVELOPMENT OF BDAT TREATMENT STANDARDS

The Agency bases numerical treatment standards for regulated constituents on the performance of well-designed and well-operated BDAT treatment systems. These standards must account for analytical limitations in available performance data and must be adjusted for variabilities related to treatment, sampling, and analytical techniques and procedures.

Concentration-based BDAT standards are determined for each constituent by multiplying the arithmetic mean of accuracy-adjusted constituent concentrations detected in the treated waste by a "variability factor" specific to each constituent. Accuracy adjustment of performance data will be discussed later in this section in relation to defining "substantial treatment."

Where EPA has identified BDAT for a particular waste, but because of data limitations or for some other compelling reason cannot define numerical treatment standards for that waste, the Agency may instead require the use of that treatment process as a technology standard.

For K060 nonwastewaters and wastewaters, the Agency is setting treatment standards for the organic and inorganic constituents as shown in Tables 7-1 and 7-2. The organic and cyanide nonwastewater treatment standards are based on the performance data from incineration of K087 waste (see Tables 4-1 through 4-3). The treatment standards for organics and total cyanides in wastewater residuals are based on performance data from biological treatment of a waste generated during coke manufacturing (see Table 4-4).

EPA's publication, Methodology for Developing BDAT Treatment Standards, details both accuracy adjustment and the determination and use

of variability factors. The accuracy-adjusted concentration for a constituent in a matrix is the analytical result multiplied by the correction factor (the reciprocal of the recovery fraction).* For example, if Compound A is measured at 2.55 mg/l and the recovery is 85 percent, the accuracy-adjusted concentration is 3.00 mg/l:

2.55 mg/l	x	1/0.85	=	3.00 mg/l
(analytical result)		(correction factor)		(accuracy-adjusted concentration)

After treatment performance data are corrected for accuracy, the arithmetic average of the corrected data is calculated for each constituent. In cases where the constituent is not detected above its detection limit, the detection limit is used to calculate the average constituent concentration in the treated waste. The next step in calculating treatment standards is to determine the variability factor for each regulated constituent. The variability factor of treated data is calculated by taking the natural log of the treated data and statistically manipulating it into a normal distribution. This is explained in detail in the methodology document.

EPA is using a variability factor of 2.8 for all of the organic constituent treatment standard calculations for K060 nonwastewaters because treatment performance for each constituent transferred from K087 was below the detection limit in the K087 incinerator ash. All of the variability factors for organic constituents in K060 wastewaters are also

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* The recovery fraction is the ratio of (1) the measured amount of constituent (or surrogate) in a spiked aliquot minus the measured amount of constituent (or surrogate) in the original unspiked aliquot to (2) the known amount of constituent (or surrogate) added to spike the original aliquot. (Refer to the Generic Quality Assurance Project Plan for Land Disposal Restrictions Program ("BDAT"), USEPA 1987).

2.8 because the treatment performance for each constituent transferred from K087 was below the detection limit.

The variability factor for cyanides in K060 wastewaters was calculated to be 1.67 based on cyanide data from incineration of K087. The variability factor for cyanides in K060 wastewaters was determined to be 2.8 because the biological treatment data from which the Agency transferred standards contained only one data point.

BDAT standards are calculated for each constituent by multiplying the arithmetic mean of the accuracy-adjusted concentrations by the variability factor of each constituent. Table 7-3 summarizes all treatment standards being established for K060 waste. Note that concentrations are expressed in terms of mg/kg and mg/l for nonwastewaters and wastewaters, respectively.

Table 7-1 Calculation of Nonwastewater Treatment Standards for K060 Waste

Constituent	Accuracy-corrected analytical values (mg/kg)	Variability factor	Treatment standard (mg/kg)
Volatile organics			
Benzene	0.026	2.8	0.071
Semivolatile organics			
Benzo(a)pyrene	1.29	2.8	3.6
Naphthalene	1.21	2.8	3.4
Phenol	1.21	2.8	3.4
Inorganics			
Cyanides	0.70	1.67	1.2

Source: USEPA 1988.

Table 7-2 Calculation of Wastewater Treatment Standards for Constituents in K060 Waste

Constituent	Accuracy-corrected analytical values (mg/l)	Variability factor	Treatment standard (mg/l)
Volatile organics			
Benzene	0.06	2.8	0.17
Semivolatile organics			
Benzo(a)pyrene	0.013	2.8	0.035
Naphthalene	0.010	2.8	0.028
Phenol	0.015	2.8	0.042
Inorganics			
Cyanides (total)	2.34	2.8	6.6

Source: USEPA 1982.

Table 7-3 Treatment Standards for K060 Waste

Constituent	Maximum for any single grab sample Nonwastewaters Total concentration (mg/kg)	Wastewaters Total concentration (mg/l)
Volatile organics		
Benzene	0.071	0.17
Semivolatile organics		
Benzo(a)pyrene	3.6	0.035
Naphthalene	3.4	0.028
Phenol	3.4	0.042
Inorganics		
Cyanides	1.2	6.6

NA - Not applicable.

8. REFERENCES

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